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ABSTRACT

This student manual, the fifth in a set of 14 modules, is designed to train emergency medical technicians (EMTs) in Ohio. The module contains two sections covering the following course content; cardiopulmonary resuscitation (CPR) (including artificial ventilation, foreign body obstructions, adjunctive equipment and special techniques, artificial circulation, precordial thump, pitfalls in the performance of cardiopulmonary resuscitation, beginning and terminating basic life support, transportation, and emergency care of the laryngectomy victim) and oxygen therapy. Each section contains objectives, an introduction, and information text. The text is illustrated with line drawings and photographs. (KC)

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EMERGENCY VICTIM CARE

ED239058

Module 5

—CPR
—Oxygen Therapy

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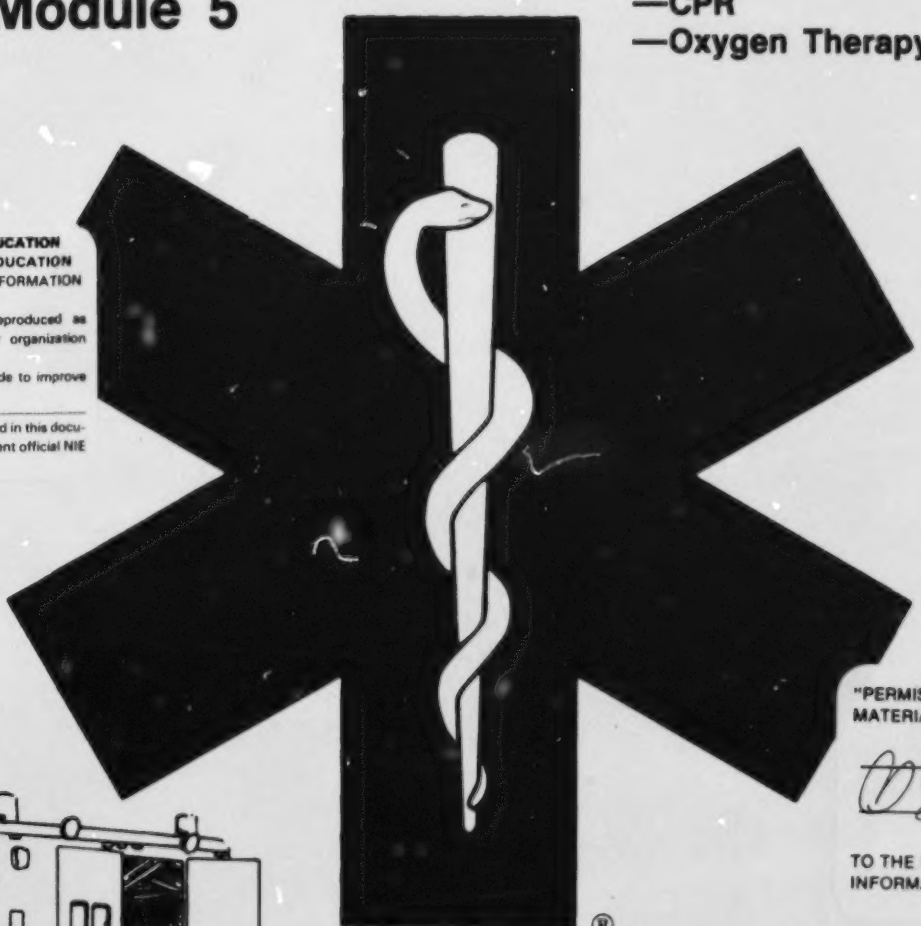

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This text is intended for use as a learning aid and to excite your curiosity and eagerness to serve patients. This text is not exhaustive and the opinions and directory comments will change from time to time as new procedures and laws become effective.

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EMERGENCY VICTIM CARE

A TRAINING MANUAL FOR EMERGENCY MEDICAL TECHNICIANS

OHIO TRADE AND INDUSTRIAL EDUCATION SERVICE

DIVISION OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF EDUCATION
COLUMBUS, OHIO

TO THE LEARNER

The 1983 Emergency Victim Care textbook revision has been grouped into 14 modules. The modules have been grouped by content matter as follows:

Module 1

Preface
Foreword
Acknowledgment
Student-Instructor Relationship

Personnel
Emergency Medical Service Vehicles
EMS Communication
Records and Reports

Module 2

Equipment
Safe Driving Practices
Legal Aspects
Controlling the Situation
Action Evaluation Conference

Module 3

Anatomy & Physiology

Module 4

Vital Signs
Patient Assessment

Module 5

Cardiopulmonary Resuscitation (CPR)

Module 6

Bleeding Control
Wounds and Bandaging
Shock

Module 7

Medical Emergencies

Module 8

Crisis Intervention
Drug-Related Problems

Module 9

Backboards/Moving and Handling the Victim
Fractures
Dislocations

Module 10

Injuries of the Eye, Ear, Nose, Abdomen, C.N.S. and Genitalia
Burns and Environmental Injuries

Module 11

Childbirth
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Module 12

Water Accidents
Electrical Emergencies
Hazardous Materials and Radiation Accidents

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MODULE 5

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CARDIOPULMONARY RESUSCITATION (CPR)

OBJECTIVES

Upon completion of the following chapter, you will be able to:

—recognize the importance for continued practice and review of cardiopulmonary resuscitation.
—describe approved application of manual artificial respiration.
—recognize the symptoms of a foreign body obstruction in the airway and identify procedure for correction.
—describe examination procedure to determine if heart compression is necessary.
—describe procedures for the application of closed chest heart compression.
—describe resuscitative procedures for the laryngectomy victim.

Following instruction and/or practice, you will be able to:

—perform approved method of manual artificial respiration.
—perform maneuvers to remove an airway obstruction.
—examine a victim to determine if heart compression is necessary.
—perform closed chest heart compression.
—properly use all adjunct resuscitation equipment.
—perform resuscitative measures on a laryngectomy victim.

INTRODUCTION

Resuscitation is a general term which covers all the measures taken to restore life or consciousness. These measures include closed chest heart compression to restore circulation (CARDIO) and artificial respiration to restore breathing (PULMONARY); thus the term CARDIOPULMONARY RESUSCITATION or, as it is commonly called, CPR. This chapter will deal with both ARTIFICIAL VENTILATION and CLOSED CHEST HEART COMPRESSION and the special techniques and adjunctive equipment that can be used with both procedures.

Much of the material in this chapter is taken from publications of the American Heart Association, Inc., and is reprinted with permission. Because of the dynamic nature of CPR, the procedures and standards are prone to change. A check with the Heart Association will yield the latest recommended procedures and standards.

NEW STANDARDS

The American Heart Association and the National Academy of Sciences-National Research Council co-sponsored a National Conference on the Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). This conference was conducted because of the changes that have occurred during the past several years.

These standards have been developed as a working guide for the proper training and performance of cardiopulmonary resuscitation and emergency cardiac care. They have been prepared by leading authorities and represent a consensus of many qualified persons from a variety of disciplines. However, the performance of cardiopulmonary resuscitation and emergency cardiac care is an art that is constantly changing and developing as the benefits of continuing experience and research become available. These standards should serve to implement changes

as required. They are in no way intended to limit new concepts or advances. Deviations from these standards may occur in certain situations not contemplated by the standards or where trained EMTs have sound basis for their actions.

GENERAL CONSIDERATIONS

It has been estimated that about one million persons in the United States each year experience acute myocardial infarction. More than 650,000 die annually of ischemic heart disease. About 350,000 of these deaths occur outside of the hospital, usually within two hours after the onset of symptoms. Thus sudden death from heart attack is the most important medical emergency today. It seems probable that a large number of these deaths can be prevented by prompt, appropriate treatment. In addition, many victims who die as a result of such accidents as drowning, electrocution, suffocation, drug intoxication, or automobile accidents could be saved by the prompt and proper application of cardiopulmonary resuscitation and emergency cardiac care.

ARTIFICIAL VENTILATION

Opening the airway and restoring breathing are the basic steps of artificial ventilation. These steps can be performed quickly under almost any circumstance and without adjunctive equipment or help from another person. They constitute emergency first aid for airway obstruction and respiratory inadequacy or arrest.

Respiratory inadequacy may result from an obstruction of the airway or from respiratory failure. An obstructed airway is sometimes difficult to recognize until the airway is opened. At other times, a partially obstructed airway is recognized by labored breathing or excess respiratory efforts. Respiratory failure is characterized by minimal or absent respiratory effort, failure of the chest or upper abdomen to move, and inability to detect air movement through the nose or mouth.

AIRWAY

The most important factor for successful resuscitation is immediate opening of the airway. This can be accomplished easily and quickly by tilting the victim's head backward as far as possible. Sometimes this simple maneuver is all that is required for breathing to resume spontaneously. To perform the head tilt, the victim must be lying backside down. The rescuer places one hand beneath the victim's neck and the other hand on the forehead. The EMT then lifts the neck with one hand and tilts the head backward by pressure with the other hand on the forehead. This maneuver extends the neck and lifts the tongue away from the back of the throat. Anatomical obstruction of the airway caused by the tongue dropping against the back of the throat is thereby relieved. The head must be maintained in this position at all times. See Figure 1.

Emphasis must be placed on the fact that hyperextension of the neck is contraindicated in victims who may have suffered a spinal injury, as it may cause permanent paralysis. In this case an alternative method of opening the airway must be used.

The head tilt method is effective in most cases. If unsuccessful in opening the air passage adequately, additional forward displacement of the lower jaw—jaw thrust—may be required. This can be accomplished by a triple airway maneuver in which the rescuer's fingers are placed behind the angles of the victim's jaw and the rescuer (1) forcefully displaces the mandible forward while (2) tilting the head backward and (3) using the thumbs to retract the lower lip to allow breathing through the mouth as well as through the nose. The jaw thrust is performed best from a position at the top of the victim's head. See Figure 2.

When using jaw thrust for mouth-to-mouth

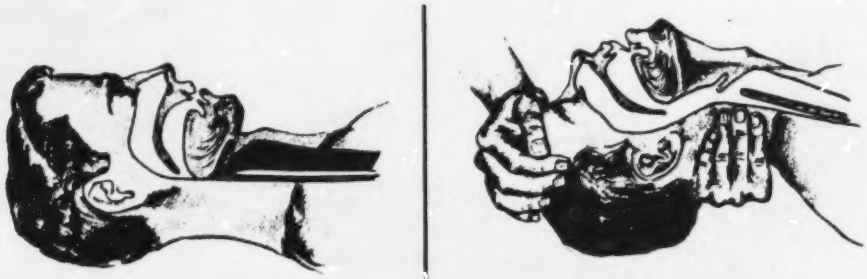


Figure 1. Head tilt

ventilation, the victim's mouth must be kept open with the rescuer's thumbs and the nose sealed by placing the cheek against it. For mouth-to-nose ventilation with jaw thrust, the rescuer's cheek is used to seal the victim's mouth. The rescuer should not retract the lower lip with the thumbs. Such special details of performance and the problems associated with mannequin practice limit use of jaw thrust techniques to specially trained personnel.

ESTABLISHING BREATHLESSNESS

After opening the airway using one of the aforementioned methods, the next step is to establish if the victim is breathing. To do this, the EMT places an ear over the victim's mouth and nose, looking forward toward the victim's chest and stomach. The next phase is to look for the rise and fall of the victim's chest, listen for air when the victim exhales, and feel for air on the EMT's cheek and ear.

BREATHING

If the victim does not promptly resume adequate spontaneous breathing after the airway is opened, artificial ventilation, sometimes called rescue breathing, must be started. Mouth-to-mouth breathing and mouth-to-nose breathing are both types of artificial ventilation.

To perform mouth-to-mouth ventilation, the rescuer's hand is placed behind the victim's neck to maintain the head in a position of maximum backward tilt. The victim's nostrils are pinched together with the thumb and index finger of the rescuer's other hand. The rescuer also continues to exert pressure on the forehead to maintain the backward head tilt. With mouth opened widely, the rescuer takes a deep breath and makes a tight seal with the mouth around the victim's mouth. The EMT then blows air into the victim's mouth. The victim's chest is watched out of the corner of the rescuer's eye to see if it is rising. If it is, the lungs are being ventilated.

This cycle is repeated once every five seconds as long as respiratory inadequacy persists.

Adequate ventilation is insured on every breath by the rescuer by:

1. Seeing the chest rise and fall.
2. Feeling in the rescuer's own airway the resistance and compliance of the victim's lungs as they expand.
3. Hearing and feeling the air escape during exhalation. The initial ventilatory maneuver

Figure 2. Jaw thrust

should be **four quick, full breaths** without allowing time for full lung deflation between breaths. See Figure 3.

Figure 3. Performing artificial ventilation

In some cases, mouth-to-nose ventilation is more effective than mouth-to-mouth ventilation. The former is recommended when it is impossible to open or ventilate through the victim's mouth, when the victim's mouth is seriously injured, when it is difficult to achieve a tight seal around the victim's mouth, and when, for some other reason, the rescuer prefers the nasal route.

For the mouth-to-nose technique, the rescuer keeps the victim's head tilted back with one hand on the forehead and uses the other hand to lift the victim's lower jaw. This seals the lips. The rescuer then takes a deep breath, seals the lips around the victim's nose and blows in until the lungs expand. The rescuer removes the mouth and victim is allowed to exhale passively. The rescuer can see the chest fall when the victim exhales. When mouth-to-nose ventilation is used, it may be necessary to open the victim's mouth or separate the lips to allow the air to escape during exhalation because the soft palate at the back of the victim's throat may cause nasopharyngeal obstruction. This cycle should be repeated approximately every five seconds. See Figure 4.

No adjuncts are required for effective rescue breathing, so artificial ventilation should never be delayed to obtain or apply adjunctive devices.

INFANTS AND CHILDREN

Opening the airway and performing artificial ventilation are essentially the same for children as for adults, except the EMT covers both the mouth and nose of a child, and the rate of ventilations is faster. The procedures are explained in detail in the chapter on Pediatric Emergency.

Figure 4. Mouth-to-nose ventilation

ACCIDENT CASES

In accident cases, it is imperative that caution be used to avoid extension of the neck when there is a possibility of neck fracture. A fractured neck should be suspected in diving or automobile accidents when the victim has lacerations of the face and forehead. **If a fracture is suspected, all forward, backward, lateral, or turning movement should be avoided.** To open the airway, a modification of the jaw thrust maneuver described above should be used. In this variation, the rescuer's hands are placed on either side of the victim's

head so the head is maintained in a fixed, neutral position without the head extended. The index fingers should then be used to displace the mandible forward without tilting the head backward or turning it to either side (modified jaw thrust). If required, artificial ventilation usually can be provided in this position. If this is unsuccessful, the head should be tilted back very slightly and another attempt made to ventilate using the modified jaw thrust maneuver.

FOREIGN BODY OBSTRUCTIONS

Upper airway obstruction can result in unconsciousness and cardiopulmonary arrest, but far more often unconsciousness and cardiopulmonary arrest will result in upper airway obstruction.

Management of upper airway obstruction must be taught within the context of basic life support. The leading cause of cardiopulmonary arrest is coronary heart disease and this accounts for more than 650,000 deaths annually. Foreign body obstruction of the airway accounted for approximately 2,900 deaths in 1974 according to the National Safety Council.

Foreign body obstruction of the airway usually occurs during eating. In adults, meat is the most common cause of obstruction, although a variety of other foods and foreign bodies have been the cause of choking in children and some adults. Common factors associated with choking on food include: (1) elevated blood alcohol; (2) upper and/or lower dentures; and (3) large, poorly chewed pieces of food. This emergency has been mistaken for a heart attack, giving rise to the name "cafe coronary."

An unconscious patient can develop airway obstruction because the tongue falls back into the pharynx, obstructing the upper airway. Regurgitation of stomach contents into the pharynx can occur during a cardiopulmonary arrest or during resuscitative attempts. Head and facial injuries may result in blood clots obstructing the upper airway, particularly if the patient is unconscious.

RECOGNITION OF FOREIGN BODY OBSTRUCTION

Because early recognition of airway obstruction is the key to successful management, it is important to differentiate this emergency from fainting, stroke, heart attack, epilepsy, or other conditions which cause sudden respiratory failure.

Foreign bodies may cause either **partial airway obstruction or complete airway obstruction.** With partial airway obstruction, the victim may be capable of either "good air exchange" or "poor air exchange." With good air exchange, the victim can cough forcefully, although frequently there is wheezing between the coughs. As long as good air exchange continues, the victim should be allowed and encouraged to persist with spontaneous coughing and breathing efforts. At this point, **do not** interfere with the victim's attempts to expel the foreign body.

Poor air exchange may occur initially, or good air exchange may progress to poor air exchange as indicated by a weak, ineffective cough, high-pitched noises while inhaling (such as a crowing like noise), increased respiratory difficulty, and possibly cyanosis (bluish color of skin, fingernail beds, and inside mouth). At this point manage the partial obstruction as though it were a complete airway obstruction.

Conscious Victim—Complete airway obstruction is recognized when a victim who is eating, or has just finished eating, is suddenly unable to speak or cough, even when asked, "Can you speak?" The victim may use the "distress signal of choking," that is, clutching the neck. The victim may appear dusky in color and show exaggerated effort to breathe. Air movement may be absent or not detectable. Prompt action is urgent, preferably while the victim is still conscious.

Within a short time, as the oxygen in the lungs is used up because the obstructed airway prevents entry of air into the lungs, unconsciousness will occur and death will follow rapidly.

Victim Found Unconscious—When a person is discovered unconscious, the cause is unknown. It may have been caused by cardiopulmonary arrest, airway obstruction, or a number of other causes. Any victim discovered unconscious must be managed as a cardiopulmonary arrest, and management of an obstructed airway dealt with only as it becomes apparent during the correct sequence of resuscitative maneuvers.

MANEUVERS FOR RELIEVING FOREIGN BODY OBSTRUCTION

Three manual maneuvers recommended for removing foreign body obstruction from the airway are back blows, manual thrust, and finger sweeps.

BACK BLOWS

Back blows consist of a rapid series of sharp blows delivered with the heel of the hand over the spine and between the shoulder blades.

Back blows may be administered with the victim sitting, standing or lying, and should be applied forcefully, in rapid succession.

Victim Standing or Sitting

1. Position yourself at the side and slightly behind the victim.

2. Deliver sharp blows with the heel of your hand to the victim's spine between the shoulder blades.

3. Place your other hand on the chest to support the victim. See Figure 5.

Figure 5. Back blow with victim standing

Victim Lying

1. Kneel and roll victim onto side, facing you, with the victim's chest against your knee(s).

2. Deliver sharp blows to the back as described above. See Figure 6.

Figure 6. Back blow with victim lying

MANUAL THRUSTS

Manual thrusts consist of a rapid series of thrusts to the upper abdomen (abdominal thrusts) or lower chest (chest thrusts).

ABDOMINAL THRUST

Victim Standing or Sitting

1. Stand behind the victim and wrap your arms around the victim's waist.

2. Grasp one fist with your other hand, and place the thumb side of your fist against the victim's abdomen, between the xiphoid and umbilicus (navel).

3. Press your fist into the victim's abdomen with a **quick, upward thrust.** See Figure 7.

Victim Lying

1. Position the victim supine (face up) with your knees close to the victim's hips.

2. Place the heel of one hand against the victim's abdomen, between the xiphoid and the umbilicus (navel). Place the second hand on top of the first.

3. Press into the victim's abdomen with a **quick, upward thrust.** See Figure 8.

Figure 7. Abdominal thrust with victim standing

NOTE: The EMT should be alert to possible regurgitation by the victim.

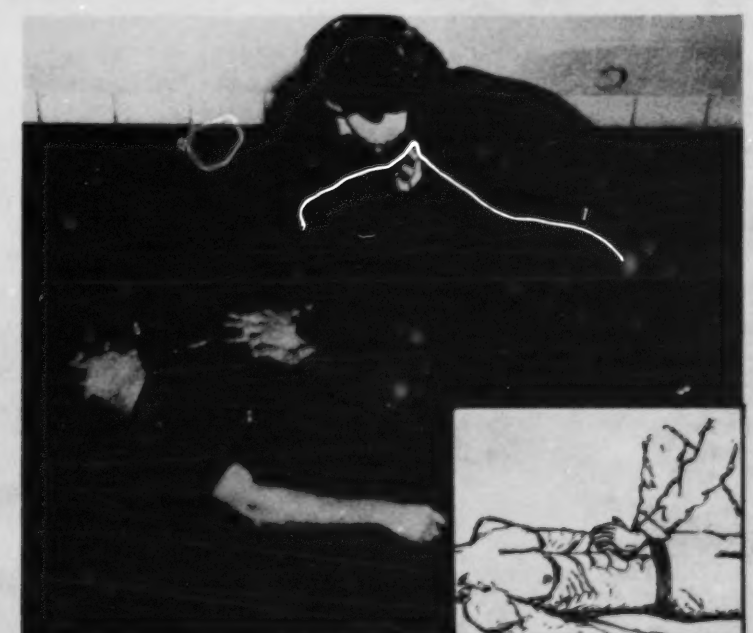


Figure 8. Abdominal thrust with victim lying

Instead of performing this maneuver from the victim's side, the rescuer may straddle either the hips or one leg of the victim.

Victim Alone—If you are the victim and alone, perform the maneuver on yourself. Press your own fist into your upper abdomen with a quick upward thrust as described for the victim standing; or lean forward and press your abdomen quickly over any firm object.

CHEST THRUST

Another method of applying the manual thrust is the chest thrust. This is particularly useful when the abdominal girth is so large the rescuer's arms cannot be fully wrapped around the victim's abdomen, as in advanced pregnancy or gross obesity.

Victim Sitting or Standing

1. Wrap your hands under the victim's arms to encircle the victim's lower chest.

2. Grasp one fist with your other hand, with the thumb side of the fist on the lower sternum, but **not on** the xiphoid process (same landmark as for cardiac massage).

3. Press into the victim's chest with a **quick, backward thrust.** See Figure 9.

Victim Lying

1. Position the victim supine (face up), your knees close to victim. See Figure 10.

2. Place the heel of the hand on the same landmark as for the standing chest thrust (lower sternum, but above xiphoid process) then place the other hand on top of the first one. Press into the victim's chest with a quick, downward thrust.

Combined Use of Back Blows and Manual Thrusts—Back blows produce an instantaneous increase in pressure in the respiratory passages, which may result in either partial or complete dislodgement of a foreign body. The manual thrusts produce a lower, though more sustained, increase in pressure in the respiratory passages and may further assist in the dislodgement of the foreign body. The **combination**

Figure 9. Chest thrust with victim standing

Figure 10. Chest thrust with victim lying

of these two techniques appears to be the most effective method of clearing upper airway obstruction, rather than isolated use of one technique.

MANUAL REMOVAL OF FOREIGN BODIES

Following back blows and the abdominal thrust, foreign bodies may become partially dislodged and accessible, yet may not be expelled. In this case, removal by the fingers should be attempted.

It is difficult to use your fingers successfully to remove foreign bodies from the airway. In most cases, it is impossible to open the victim's mouth and insert your fingers for this purpose, unless the victim is unconscious. In some cases, especially those involving infants and small children, an adult finger may force the foreign body deeper into the throat, causing complete obstruction. However, large foreign bodies can sometimes be dislodged and removed if they are at the level of, or above, the epiglottis.

Finger Sweep—Insert your index finger down the inside of the cheek, deeply into the throat to the base of the tongue, after opening the mouth with your other hand by using the cross-finger technique or jaw lift. Then using a hooking action, dislodge the foreign body and maneuver it into the mouth. Sometimes it is necessary to use the index finger to push the foreign body against the opposite side of the throat to dislodge it. Be careful not to force the object deeper into the airway. If the foreign body comes within reach, grasp and remove.

SEQUENCE OF MANEUVERS

The recommended sequence of maneuvers varies according to whether the emergency involves: (1) a conscious victim or (2) an unconscious victim. The sequence for each condition follows.

1. Conscious Victim—The urgency of this situation cannot be overemphasized. Immediate recognition and proper action are essential. If the victim has good air exchange, only partial obstruction and is able to speak or cough effectively, **do not** interfere with the victim's attempts to expel a foreign body.

When complete airway obstruction is recognized, the following sequence should be performed quickly on the conscious victim in the sitting, standing or lying position.

a. Conscious
   (1) 4 Back blows.
   (2) 4 Manual thrusts.
   (3) Alternate until effective, or person becomes unconscious.

b. Becomes Unconscious
   (1) Place in supine (face up) position.
   (2) Open airway and attempt to ventilate.
   (3) If unsuccessful:
      (a) 4 Back blows.
      (b) 4 Manual thrusts.
      (c) Open mouth using cross-finger technique or jaw lift; finger probe to clear airway.

2. **Victim Found Unconscious - Cause Unknown**—Sudden collapse and loss of consciousness is a grave emergency. Even when someone has been eating, and this emergency occurs, it may be due to fainting, stroke or heart attack, as well as anoxia (lack of oxygen) from foreign body obstruction. Anoxia of four to six minutes duration may result in irreversible brain damage.

a. Establish unresponsiveness.

b. Establish airway, check for breathing and attempt to ventilate. **In cases of suspected neck injury the airway is opened by modified jaw thrust rather than head tilt.**

c. If unable to ventilate, reposition head and attempt to ventilate.

d. If unsuccessful:
   (1) 4 Back blows.
   (2) 4 Manual thrusts.
   (3) Open mouth using cross-finger technique or jaw lift; finger probe and clear airway.

e. Reposition head and attempt to ventilate.

f. If unsuccessful, repeat steps d and e.

REMEMBER:

Persist. As the victim becomes more anoxic, the muscles relax and maneuvers which were previously ineffective may become effective.

When the muscles relax or when a foreign body is partially dislodged and the airway is partially open, slow, forceful ventilations may keep a victim alive by bypassing the obstruction.

If there is vomitus in the mouth or pharynx, turn the head to the side, wipe it out quickly, and proceed with the sequence.

GASTRIC DISTENSION

Artificial ventilation frequently causes distension of the stomach. This occurs most often in children, but it is not uncommon in adults. It is most likely to occur when excessive pressures are used for inflation or if the airway is obstructed. Marked distension of the stomach may be dangerous because it promotes regurgitation, and it reduces lung volume by elevating the diaphragm. If the stomach becomes distended during rescue breathing, recheck and reposition the airway, observe the rise and fall of the chest, and avoid excessive airway pressure. **(Continue rescue breathing without attempting to expel the stomach contents.)** Experience in the field has shown that attempting to relieve stomach distention by manual pressure over the upper abdomen may cause the victim to regurgitate and, when suctioning equipment is not available, aspiration of stomach contents into the lungs may occur. If severe gastric distension results in inadequate ventilation and cannot be corrected by repositioning the airway, pressure over the epigastrium (after placing the victim on side) to expel the air from the stomach may be necessary despite the risk of inducing regurgitation and aspiration. If regurgitation does occur whenever performing CPR, turn the victim's entire body on the side, wipe out the mouth, and continue CPR.

ADJUNCTIVE EQUIPMENT AND SPECIAL TECHNIQUES

Adjunctive equipment is not essential for cardiopulmonary resuscitation. It may be used when it becomes available, but only by specialized personnel who have had adequate training with the specific devices to be used. Basic life support should not be delayed while awaiting equipment, nor should use of equipment result in diverting attention or effort from basic resuscitative measures. When considering adjunctive equipment, it must be remembered that personnel must be trained to a level of demonstrated proficiency in the use of adjunctive equipment, even equipment of a relatively simple nature. In addition, adjunctive equipment must be tested periodically for satisfactory performance according to prescribed regulations. Adequate records of such tests also must be maintained.

ADJUNCTS FOR AIRWAY AND VENTILATION

Oxygen—Supplemental oxygen should be used as soon as it becomes available. **It is recommended that supplemental oxygen always be used when bag-valve-mask devices or bag-valve-tube systems are used.** This will enhance myocardial and cerebral oxygenation that is essential for successful resuscitation.

Oropharyngeal Airway—Oropharyngeal airways should be used whenever a bag-valve-system or automatic breathing device with mask is used, but only if done by an individual properly trained in their use. Airways should be used only on deeply unconscious persons. If introduced into a conscious or stuporous person, it may promote vomiting or laryngospasm. Care

is required in the placement of the airway because incorrect insertion can displace the tongue back into the pharynx and produce airway obstruction. Oropharyngeal airways should be available in infant, child, and adult sizes. See Figure 11. As with all adjunctive equipment, explicit training and practice is required for their use.

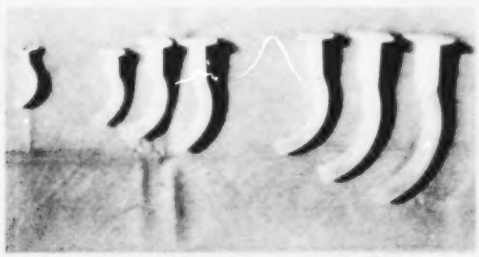


Figure 11. Airways: newborn size, three child sizes, and three adult sizes.

The best way to ascertain the correct size of an airway is to hold the airway to the side of the face. The lower tip should touch the angle of the chin (just below the ear lobe) and the other end should extend beyond the lips.

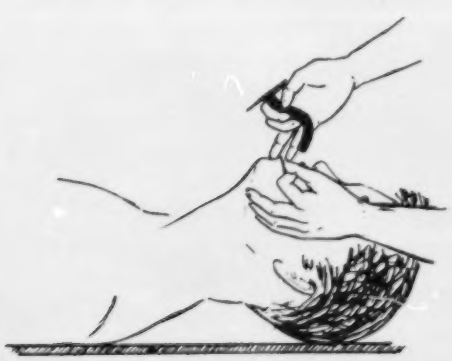


Figure 12. Inserting the airway

To insert the airway, put its tip against the roof of the mouth, just behind the upper teeth, and slide it down a distance determined by the size of the victim's throat. All airways should be inserted according to the contour of the victim's air passage. See Figure 12. Always remember to keep the victim's tongue out of the way while inserting the airway. A tongue blade may be helpful.

Another acceptable way of inserting the airway is to start the airway in the victim's mouth upside down. After partially inserting the airway, rotate it 180° so it fits the contour of the victim's throat. The airway is in place.

As soon as the airway is in place, resuscitation should be resumed.

Masks—Well-fitting masks have proven to be effective, simple adjuncts available for use in artificial ventilation by medical, allied health, and nonmedical personnel. Manikin practice with masks should be required for all personnel who are likely to use a mask for mouth-to-mouth ventilation. The mask may be a standard anesthesia mask or a folding pocket mask and should have the following characteristics: transparent material, well-sealing cuff, headstraps, oxygen insufflation inlet, 15 mm/22 mm (I.D./O.D.) coupling size, and availability in one average size for adults and additional sizes for infants and children. The mask is most effectively used when the rescuer is positioned at the top of the patient's head and uses the jaw thrust maneuver.

Bag-Valve Devices—When bag-valve units are used, they usually provide less ventilatory volume than mouth-to-mouth or mouth-to-mask ventilation because of the difficulty in providing a leakproof seal to the face while maintaining an open airway. For this reason, the manually operated, self-inflating bag-valve-mask units can be used effectively only by well-trained and experienced medical personnel.

Extensive specialized training and demonstrated continual proficiency is required with the bag-valve device. The rescuer must be positioned at the top of the victim's head; then must maintain the head in extension, keeping the lower jaw elevated, and using other hand to squeeze the bag. See Figures 13 and 14. Attempts have been made to achieve effec-

Figure 13. While pressing the mask tightly to the face, the jaw is kept forward and the head tilted back by keeping an upward pressure on the lower jaw as indicated.

Figure 14. Grasp the resuscitator bag with the fingers spread wide as shown. Squeeze until the victim's chest rises, then release pressure.

tive ventilation with these devices by using two rescuers, one to hold the mask and one to squeeze the bag, but this is an awkward procedure. This device is effective when used with an oral airway; but because of the difficulty in using the bag-valve-mask unit, it is recommended these devices be used only when the victim has a cuffed endotracheal tube or a cuffed esophageal obturator airway inserted. Either of these tubes will ensure delivery of an adequate volume of oxygen-enriched atmosphere and will prevent gastric insufflation and aspiration of stomach contents. When an endotracheal tube is used, the rescuer may be positioned at the victim's side. When a mask is used, or esophageal obturator airway, the rescuer always should be positioned at the top of the victim's head and not at the side.

An adequate bag-valve-mask unit should fulfill the following criteria.

1. Self-refilling, **but without sponge rubber inside** because of difficulty in cleaning, disinfecting, eliminating ethylene oxide, and fragmentation.

2. Non-jam valve system at 15 liters/minute oxygen inlet flow.

3. Transparent, plastic face mask with an air-filled or contoured, resilient cuff.

4. No pop-off valve, except pediatric models.

5. Standard 15 mm/22mm fittings.

6. System for delivery of high concentrations of oxygen through an ancillary oxygen inlet at the back of the bag or via an oxygen reservoir.

7. True non-rebreathing valve.

8. Satisfactory for practice on manikins.

9. Satisfactory performance under all common environmental conditions and extremes of temperature.

10. Available in adult and pediatric sizes.

Esophageal Obturator Airway—Written approval by the emergency medical services advisor must be obtained before the use of this equipment is possible.

Esophageal Obturator Airway—The esophageal obturator airway is a recent innovation in the management of cardiac arrest patients. See Figure 15. It appears to be a useful airway adjunct, but its future role remains to be determined. The airway consists of a cuffed endotracheal tube mounted through a face mask and modified with a soft plastic obturator blocking the distal orifice and multiple openings in the upper one-third of the tube at the level of the pharynx.

The potential advantages of the esophageal obturator airway are that no visualization is required for introduction and it can be introduced more easily and quickly than an endotracheal tube. In a large series of cardiac arrest cases, the airway has been shown to be used successfully without injury to the esophagus when used by professional allied health personnel who had been trained in its use on intubation manikins and unconscious patients. However, the potential for damage to the esophagus is ever present unless use of the airway is restricted to adequately trained individuals.

The following is a step-by-step procedure of the use of the esophageal airway.

1. In order to insert this airway into the esophagus, the lower jaw is grasped with the thumb and forefinger and pulled forward, while the tube itself is blindly inserted into the mouth and pharynx. With the tube following the natural curvature of the pharynx, in most cases it will pass directly into the esophagus. This maneuver is usually facilitated by flexing the head forward.

2. The tube is advanced until the mask is seated on the face. When this is accomplished, the cuff will lie below the level of the carina of the trachea. If the cuff is above the level of the carina, when inflated it may compress the posterior membranous portion of the trachea and cause tracheal obstruction.

Figure 15. Esophageal obturator airway

3. Because there is always the possibility that the tube may become lodged in the trachea, the next step is to blow into the airway (or use a bag-valve device) and observe for chest expansion.

4. If the chest rises, the tube is in the esophagus, and the cuff then may be inflated. A maximum volume of 35 ml of air should be used for cuff inflation. If the chest does not rise, the airway is not in the esophagus and may be in the trachea. The airway should be removed immediately and ventilating by another method should be continued.

5. With the face mask properly fitted over the face and the cuff inflated, air may be introduced into the tube, either by blowing into it or with a bag-valve device or a mechanical resuscitator. The pressurized air enters the upper end of the esophageal airway and then exits through the side holes which are now located in the pharynx. Because air is prevented from entering the esophagus due to the pressure of the inflated cuff, the air then passes down the trachea and inflates the lungs.

6. Possible or theoretical hazards associated with the use of this device include rupture of

the esophagus from excessive inflation of the cuff or vomiting by the victim. The esophageal airway may become located in the trachea instead of the esophagus so that air will enter the stomach rather than the lungs. For this reason, proper ventilation of the lungs must always be assured with the use of a stethoscope as soon as possible.

7. The use of this device can cause gagging or vomiting in conscious or semi-conscious victims who are responsive. Therefore it should be used only in unconscious patients. It should not be used in children under the age of 16, or in cases of known esophageal disease, or when caustic poisons have been ingested. It should be employed only for short-term use (several hours) and should be withdrawn as soon as the victim begins to resume spontaneous ventilations.

8. Removal of the esophageal airway frequently is followed by immediate regurgitation. Therefore suction devices or aspirators must be ready and operating before the removal of the esophageal obturator.

OXYGEN-POWERED MECHANICAL BREATHING DEVICES

CONVENTIONAL PRESSURE-CYCLED AUTOMATIC RESUSCITATORS (IPPB respirators, positive-negative pressure resuscitators-inhalers) **should not** be used in conjunction with external cardiac compression because effective, external cardiac compression prematurely triggers termination of the inflation cycle so inadequate ventilation results. These devices are complex, difficult to use, more costly, and relatively less effective, than oxygen-powered ventilation devices that are manually triggeres (time-cycled), even for artificial ventilation alone.

Manually triggered (time-cycled) devices are easier to use effectively. They have high, instantaneous flow rates that allow them to be used for artificial ventilation alone. The devices also allow breaths to be interposed between compressions during CPR. Most will function as inhalators too for patients who are breathing spontaneously but require oxygen.

Manually triggered, oxygen-powered resuscitators should be able to:

1. Provide instantaneous flow rates of 100 liters/minute or more and inspiratory pressure safety release valve that opens at 50 cm of water; although it is recognized that this high instantaneous flow rate may result in gastric distension unless a cuffed endotracheal tube or cuffed esophageal obturator airway is used.
2. Provide 100% oxygen.
3. Operate satisfactorily under environmental conditions, including all temperature extremes found in North America.

They also should have the following minimum design criteria.

1. A standard 15 mm/22mm (I.D./O.D.) coupling for mask, endotracheal tube, esophageal airway, and tracheostomy tubes.
2. A rugged, breakage-resistant mechanical design that is compact and easy to hold.
3. A trigger positioned so both hands of the rescuer can remain on the mask to hold it in position while supporting and tilting the victim's head and keeping the jaw elevated.

Suction Devices—Portable and installed suction equipment should be available for resuscitation emergencies. The portable unit should provide vacuum and flow adequate for pharyngeal suction tubing and semirigid pharyngeal suction tips. There should be multiple clean suction catheters of various sizes for suctioning via endotracheal or tracheostomy tubes, a nonbreakable collection bottle, and a supply of water for rinsing tubes and catheters.

The installed suction unit should be powerful enough to provide an air flow of over 30 liters/minute at the end of the delivery tube and a vacuum of over 300 mm Hg when the tube is clamped. The amount of suction should be controllable for use on children and intubated victims.

There should be an additional set of rigid pharyngeal suction tips (tonsil suction tips) and

sterile curved tracheal suction catheters of various sizes. For tracheal suction, a Y- or T-piece or a lateral opening should be between the suction tube and suction source for on-off control. The suction yoke, collection bottle, water for rinsing, and suction tube should be readily accessible to the attendant at the head of the litter. The tube should reach the airway of any victim, regardless of the victim's position. Suction apparatus must be designed for easy cleaning and decontamination.

When suctioning mucus out of a victim's mouth and throat, the suction catheter or tip must be moved about so as to include all areas of the mouth and throat; and so that it will not attach itself by means of suction to the inside of the victim's mouth, thus preventing it from fulfilling its purpose.

Insertion can be continued slowly while rotating the catheter as long as mucus is present. Caution must be used when using the hard catheters to avoid trauma to the larynx. Continuous suction should be applied for **no more than five seconds at a time** without some type of ventilation for the victim.

Manual Chest Compressors—Simple, hinged, manually operated mechanical chest compressors can be used for effective external cardiac compression. They should provide an adjustable stroke of 1½ to 2 inches and be able to be applied with interruptions in manual CPR of no longer than five seconds each. These compressors are inexpensive and make it easier for an individual to provide prolonged, effective external cardiac compression.

Automatic Chest Compressors—Optimum management of persons with cardiac arrest is obtained when the definitive therapy required to restore spontaneous circulation and stabilize the victim is available at the site of the arrest, prior to any transportation that may be necessary. When this is not possible, the use of an automatic mechanical device provides the most consistently effective cardiopulmonary resuscitation during transportation or prolonged resuscitation. When such devices are used, external cardiac compression always must be started with the manual method first. Physicians and other medical personnel who will be using the automatic equipment must have careful and extensive training and manikin practice in the manual method, the mechanical method, and the proper technique for changing from one to the other without interrupting CPR for more than five to 10 seconds at any one time. A well-trained and coordinated team of persons is necessary to use the compressor.

The devices eliminate the operator fatigue that causes variations in cardiac output. They also provide simultaneous ventilation with high oxygen concentrations. While these devices afford more regular and uninterrupted CPR, they have the following limitations.

1. They are relatively heavy and difficult to move because of their associated oxygen tanks and components.

2. They may be difficult to use without accidentally displacing the plunger while moving a victim up and down stairs or on a steep incline.

3. Oxygen supply is needed.

Compressor-ventilators should be employed only with a cuffed endotracheal tube, esophageal airway or, if used with a mask, only by well-trained and experienced personnel. Their performances should be comparable to that recommended for the manual method.

ARTIFICIAL CIRCULATION (External Cardiac Compression)

When sudden, unexpected cardiac arrest occurs, all of the A-B-Cs of basic life support are required in rapid succession. This includes both artificial ventilation and artificial circulation (external cardiac compression). Cardiac arrest is recognized by pulselessness in large arteries in an unconscious victim having a death-like appearance and an absence of breathing. The status of the carotid pulse should be checked as quickly as possible when cardiac arrest is suspected. In a cardiac arrest, the rescuer first opens the airway and quickly ventilates the lungs four times. Then the rescuer maintains the head tilt with one hand on the forehead, and with the tips of the index and middle fingers on the other hand, gently locates the victim's larynx and slides the fingers laterally onto the groove between the trachea and the muscles at the side of the neck where the carotid pulse can be felt. The pulse area must be **felt gently, not compressed.** See Figure 16. Palpate the carotid pulse on the same side the EMT is on, being extremely careful not to palpate both carotid pulses at the same time.

There are a number of reasons for recommending palpation of the carotid pulse rather than other pulses. First, the rescuer already is at the victim's head to perform artificial ventilation and the carotid pulse is in the same area. Second, the neck area generally is accessible immediately, without removal of clothing. Third, the carotid arteries are central and sometimes these pulses will persist when more peripheral pulses are no longer palpable. Trainees should practice palpation of the carotid pulse during classes. It is not practical to feel the carotid pulse in infants and small children. Instead, the rescuer's hand should be placed gently over the precordium (area over the heart) to feel the apical beat. The femoral pulse also can be used.

Absence of questionable presence of the pulse is the indication for starting artificial circulation

Figure 16. Checking carotid pulse

by means of external cardiac compression. External cardiac compression consists of the rhythmic application of pressure over the lower one-half of the sternum (see Figure 17) but **not over the xiphoid process.** The heart lies slightly to the left of the middle of the chest between the lower sternum and the spine. Intermittent pressure applied to the sternum compresses the heart and produces a pulsatile artificial circulation. During cardiac arrest, properly performed external cardiac compression can produce systolic blood pressure peaks of over 100 mm Hg, but the diastolic pressure is zero and the mean pressure seldom exceeds 40 mm Hg in the carotid arteries. **The carotid artery blood flow resulting from external cardiac compression on a cardiac arrest victim usually is only one-quarter to one-third of normal.**

External cardiac compression always must be accompanied by artificial ventilation. Compression of the sternum produces some ventilation, but the volumes are insufficient for adequate

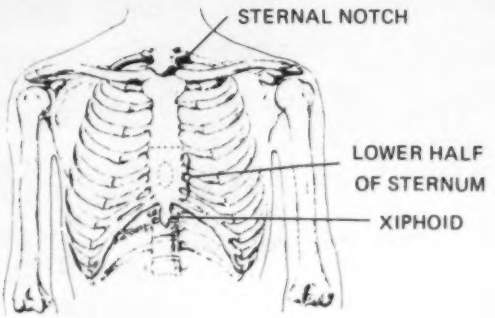
oxygenation of the blood. Therefore, artificial ventilation is **always** required when external cardiac compression is used.

TECHNIQUE FOR EXTERNAL CARDIAC COMPRESSION

The patient always must be in the horizontal position when external cardiac compression is performed since, during cardiac arrest, there is no blood flow to the brain when the body is in the vertical position, even during properly performed external cardiac compression. It is imperative, therefore, to place the cardiac arrest victim in a horizontal position as quickly as possible. In some situations a victim may be found vertical, such as in a dental chair, trapped in a vehicle, stricken on a telephone pole, while in a stadium seat, or in any similar situation. **Elevation of the lower extremities,** while keeping the rest of the body horizontal, may promote venous return and augment artificial circulation during external cardiac compression.

Effective external cardiac compression requires sufficient pressure to depress an adult's lower sternum a minimum of one and a half to two inches. For external cardiac compression to be effective, the victim must be on a firm surface. This may be the ground, floor, or a spineboard on a wheeled litter. If the victim is in bed, a board (preferably the full width of the bed) should be placed under the victim's back. However, chest compression must not be delayed while this support is awaited.

The rescuer should be positioned close to the victim's side and place the long axis of the heel of one hand parallel to and over the long axis of the lower one-half of the sternum. Great care must be exercised not to place the hand over the lower tip of the sternum (xiphoid process) that extends downward over the upper abdomen. To avoid this, the tip of the xiphoid is felt and the heel of the rescuer's hand is placed on the lower one-half of the sternum about one to one and a half inches away from the top of the xiphoid and toward the victim's head. See Figure 18. An alternate method is to feel the



LANDMARKS FOR EXTERNAL CARDIAC MASSAGE DIVIDE THE STERNUM INTO TWO HALVES. THE MID POINT OF THE LOWER HALF OF THE STERNUM IS THE CORRECT POINT FOR THE APPLICATION OF CARDIAC MASSAGE.

Figure 17. Sternum landmarks for external cardiac massage

sternal notch and the xiphoid. See Figure 19. Draw an imaginary line across the sternum halfway between these two landmarks. Now select a point halfway between this imaginary line and the xiphoid. This is the correct point for the heel of the hand in CPR. The rescuer then places the other hand on top of the first one (and may interlock the fingers), brings the shoulders directly over the victim's sternum (keeping arms straight), and exerts pressure almost vertically downward to depress the lower sternum a minimum of one and a half to two inches. The compressions must be regular, smooth, and uninterrupted. Relaxation must immediately follow compression and be of equal duration. The heel of the rescuer's hand should not be removed from the chest during relaxation but pressure on the sternum should be completely released so it returns to its normal resting position between compressions. See Figure 20.

Since artificial circulation always must be combined with artificial ventilation, it is preferable to have two rescuers. One rescuer is positioned at the victim's side and performs external cardiac compression while the other remains at the victim's head on the opposite

Figure 18. Locating tip of xiphoid to determine hand placement

Figure 19. Locating sternal notch and xiphoid to determine hand placement

side if possible, keeping the head tilted back, and continues rescue breathing. **The compression rate for two rescuers is 60 per minute.** When performed without interruption, this rate can maintain adequate blood flow and pressure and will allow cardiac refill. This rate is practical because it avoids fatigue, facilitates timing on the basis of one compression per second, and allows optimum ventilation and circulation to be achieved by quickly interposing one inflation after each five chest compressions **without any pause in compression** (5:1 ratio). The rate of 60 compressions per minute allows breaths to be interposed without any pauses in compression; this is important, since any interruption in cardiac compression results in a drop in blood flow and pressure to zero.

Two rescuers can perform CPR best when they are on opposite sides of the victim. They can then switch positions when necessary without serious interruption in the 5:1 sequence. The switch is initiated when the rescuer who is performing compressions directs that a switch take place at the end of a 5:1 sequence. The rescuer who is performing the ventilations, after giving a breath, moves into position to give

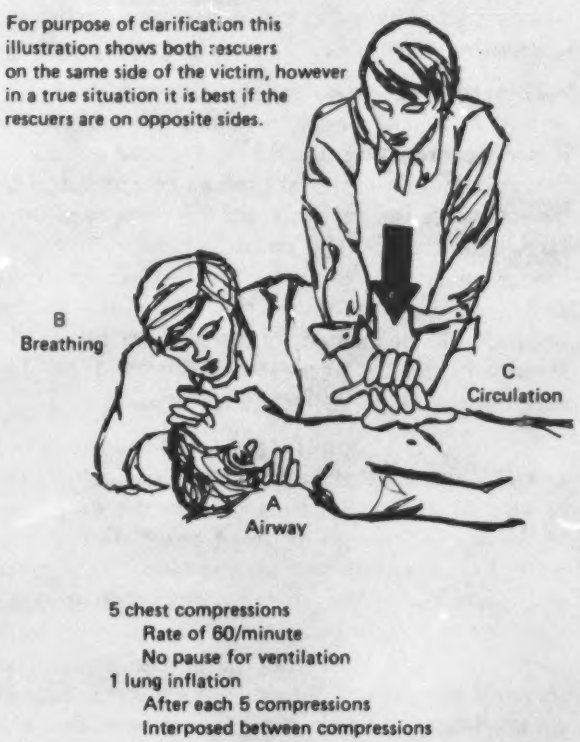

For purpose of clarification this illustration shows both rescuers on the same side of the victim, however in a true situation it is best if the rescuers are on opposite sides.
B
Breathing
C
Circulation
A
Airway
5 chest compressions
Rate of 60/minute
No pause for ventilation
1 lung inflation
After each 5 compressions
Interposed between compressions

Figure 20. Two-rescuer cardiopulmonary resuscitation

compressions. The rescuer giving compressions, after giving the fifth compression, moves to the victim's head and checks the pulse for five seconds, but no longer. If no pulse is felt, the rescuer at the head gives a breath and telis the rescuer at the chest to "continue CPR." If there is a pulse but no breathing, the rescuer should say there is a pulse and give artificial respiration.

If the victim's trachea has been intubated, lung inflation is easier and compression rates up to 80 per minute can be used since breaths can be either interposed or superimposed following endotracheal intubation.

When there is only one rescuer, that person must perform both artificial circulation and ventilation using a 15:2 ratio. This consists of **two, very quick lung inflations after each 15 chest compressions** (see Figure 21). Because of the interruptions for lung inflation, the single cuer must perform each series of 15 chest compressions at the faster rate of **80 compressions per minute** in order to achieve an actual compression rate of 60 per minute. The two full lung inflations must be delivered in rapid succession within a period of three to five seconds, without allowing full exhalation between the breaths. If time for full exhalation was allowed, the additional time required would reduce the number of compressions and ventilations that could be achieved in a one-minute period. This takes rapid movement from compression to airway.

Figure 21. One-rescuer cardiopulmonary resuscitation

Infants and Children—With a few exceptions, the cardiac compression technique is similar for children and is explained in detail in the chapter on Pediatric Emergency.

PRECORDIAL THUMP

Continuing research and clinical experience have delineated a role for the precordial thump, but only in specific types of cardiac arrest cases. Recognizing both the limitations and usefulness of the precordial thump, the American Heart Association recommends the precordial thump as a maneuver to be used by rescuers following the detection of pulselessness in **monitored** victims.

The effectiveness of the precordial thump in the unmonitored patient or in an unwitnessed cardiac arrest has not been determined. Since the myocardium frequently may be anoxic in these situations, a specific recommendation for precordial thump cannot be made for them. At this time the precordial thump is not recommended for use on children.

In cases where the primary cause of cardiac arrest is not hypoxia (low oxygen content), such as in a monitored patient, a single precordial thump may be effective in restarting circulation and may reverse certain dysrhythmias (disturbance of rhythm) if performed within the first minute after arrest. In those situations, an initial thump on the midsternum using the fist may be the first maneuver performed following the determination of pulselessness on the monitor.

Such a blow generates a small electrical stimulus in a heart that is reactive. The thump may be effective in restoring a beat in cases of ventricular asystole due to block, and in reversing ventricular tachycardia, or ventricular fibrillation of recent onset. When necessary, it may be possible to use the fist as a pacemaker in some cases of heart block. When a series of chest thumps are used for this purpose, the pulse should be palpated before each thump.

The precordial thump is not useful for anoxic asystole and cannot be depended upon to convert an established ventricular fibrillation. It should not be used for a ventricular tachycardia that is providing adequate circulation.

The precordial thump should be used to provide a stimulus to a potentially reactive heart. **However, it is not a substitute for effective external cardiac compression.**

There also are hazards associated with the precordial thump. In cases of an anoxic heart that is still beating, the low voltage stimulus may induce ventricular fibrillation. In addition, persons who restrict themselves to the recommended single blow may delay starting effective CPR.

In delivering the precordial thump, the following rules should be followed.

1. Deliver a sharp, quick single blow over the mid-portion of the sternum; hitting with the bottom, fleshy portion of the fist; striking from eight to 12 inches over the chest. See Figure 22.

2. Deliver the thump within the first minute after cardiac arrest.

The following is a procedure that is to be used only by the emergency medical service that has advanced cardiac life support equipment and personnel trained in its use by licensed physicians or registered nurses.

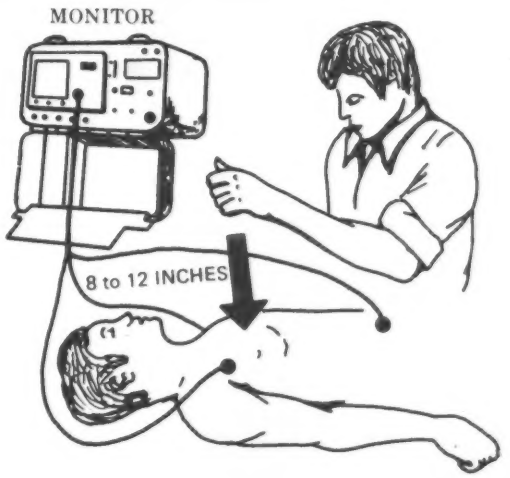


Figure 22. Precordial thump

Technique for Monitored Patient—(For use with patients who have sudden ventricular fibrillation [VF], asystole, or ventricular tachycardia [VT] without pulse.)

1. Give a single precordial thump.
2. Quickly check the monitor for cardiac rhythm and simultaneously check carotid pulse.
3. If there is ventricular fibrillation or ventricular tachycardia without a pulse, countershock as soon as possible.
4. If the pulse is absent, tilt the head, give four, quick, full lung inflations.
5. Check the carotid pulse again.
6. If the pulse is absent, begin one-rescuer or two-rescuer CPR.

It must be emphasized strongly that no time should be lost in waiting to assess the results of the precordial thump or by delivering repeated precordial thump.

PITFALLS IN PERFORMANCE OF CPR

When CPR is performed improperly or inadequately, artificial ventilation and artificial circulation may be ineffective in providing life support. Enumerated below are important points to remember in performing external cardiac compression and artificial ventilation.

1. Do not interrupt CPR for more than five seconds for any reason, except in the following circumstances.

a. Under emergency conditions, endotracheal intubation usually cannot be accomplished in five seconds. However, it is an advanced life support measure and should be performed only by those who are well trained and well practiced in the technique and **only** after the victim has been properly positioned and all preparations made. Even under these circumstances, interruptions in CPR for endotracheal intubation should never exceed 15 seconds.

b. When moving a victim up or down a stairway, it is difficult to continue effective CPR. Under these circumstances, it is best to perform effective CPR at the head or foot of the stairs, then interrupt CPR at a given signal and move quickly to the next level where effective CPR is resumed. Such interruptions usually should not exceed 15 seconds. The victim should be carried headfirst so that the head is level with the body or lower.

2. Until stabilized, ready for transportation or until arrangements have been made for uninterrupted CPR during movement, the patient should not be moved to a more convenient site.

3. Never compress the xiphoid process at the tip of the sternum. The xiphoid extends downward over the abdomen. Pressure on it may cause laceration of the liver, which can lead to severe internal bleeding.

4. Between compressions, the heel of the hand must completely release its pressure but should remain in constant contact with the chest wall over the lower half of the sternum.

5. The rescuer's fingers should not rest on the victim's ribs during compression. Interlocking the fingers of the two hands may help avoid this. Pressure with fingers on the ribs or lateral pressure increases the possibility of rib fractures.

6. Sudden or jerking movement should be avoided when compressing the chest. The compression should be smooth, regular and uninterrupted (50% of the cycle should be compression and 50% should be relaxation). Quick jabs increase the possibility of injury and produce quick jets of flow; they do not enhance stroke volume or mean flow and pressure.

7. Do not maintain continuous pressure on the abdomen to decompress the stomach while performing external cardiac compression. This may trap the liver and could cause it to rupture.

8. The shoulders of the rescuer should be directly over the victim's sternum. The elbows should be straight. Pressure is applied vertically downward on the lower sternum. This provides a maximally effective thrust, minimal fatigue for the rescuer, and reduced hazard of complications for the victim. When the victim is on the ground or floor, the rescuer can kneel at the victim's side. When the victim is on a bed or high-wheeled litter, the rescuer must be on a step or kneeling on the bed or litter. With a low-wheeled litter, the rescuer can stand at the victim's side. Problems arise with the use of low-wheeled litters in ambulances. Special arrangements must be made for proper positioning of the rescuer based on the design of the ambulance.

9. The lower sternum of an adult must be depressed one and a half to two inches by external cardiac compression. Lesser amounts of compression are ineffectual since even properly performed cardiac compression provides only about one-quarter to one-third the normal blood flow.

10. While complications may result from improperly performed external cardiac compression and precordial thumps, even properly

performed external cardiac compression may cause rib fractures in some patients. Other complications that may occur with properly performed CPR include fracture of the sternum, costochondral separation, pneumothorax, hemothorax, lung contusions, lacerations of the liver and fat emboli. These complications can be minimized by careful attention to details of performance. It must be remembered, however, that during cardiac arrest, effective cardiopulmonary resuscitation is required even if it results in complications, since the alternative to effective CPR is death.

BEGINNING AND TERMINATING BASIC LIFE SUPPORT

CPR is most effective when started immediately after cardiac arrest. If cardiac arrest has persisted for more than 10 minutes cardiopulmonary resuscitation is unlikely to restore the victim to pre-arrest central nervous system status. If there is any question of the exact duration of the arrest, the victim should be given the benefit of the doubt and resuscitation started.

Basic life support is not indicated for a victim who is known to be in the terminal stages of an incurable condition. When resuscitation is indicated and started in the absence of a physician, it should be continued until one of the following occurs:

1. Effective spontaneous circulation and ventilation have been restored.
2. Resuscitation efforts have been transferred to another responsible person who continues basic life support.
3. A physician assumes responsibility.
4. The victim is transferred to properly trained and designated professional medical or allied health personnel charged with responsibilities for emergency medical services.
5. The rescuer is exhausted and unable to continue resuscitation.

The decision to stop resuscitative efforts is a medical one.

TRANSPORTATION

With the victim on a backboard, closed chest heart compression and resuscitation can be carried out and continued while loading into the emergency vehicle and while en route to the hospital. See Figures 23 and 24.

The hospital to which the emergency service is en route should be notified of the victim's pending arrival. This will allow time for the emergency room team to prepare equipment and drugs before the victim arrives.

CONCLUSION

This resuscitation procedure cannot be learned just by reading material in a text. Continual practice and experience are necessary. The procedure should be reviewed often.

Figure 23. Preparing to load victim

Figure 24. Loading victim

EMERGENCY CARE OF THE LARYNGECTOMY VICTIM

Any victim who has had the larynx (voice box, also "Adam's Apple") removed requires special emergency care. These are people who because of some disease, accident, or other medical condition, have had surgery performed on their voice box with the end result of its being partially or totally removed.

From the time of surgery, these people will never again breathe through their mouths. At the time of the removal of the "Adam's Apple," an opening is made at the lower part of the neck, just above the breastbone. It is through this opening that the "laryngect" must breathe forever. They are commonly referred to as "the neck breathers."

As shown in Figure 25, a patient's neck is exposed and the "stoma" (permanent opening in the neck to the windpipe) is visible.

Figure 25. After laryngectomy, person receives air into the lungs through neck opening (stoma)

If the patient's shirt was closed or a T-shirt or a shirt and tie was worn, the stoma would not easily be seen.

Some people with stomas wear high necklaces or scarves. These partially cover the opening and unless closely investigated, might be overlooked.

A side view of the person in Figure 26 shows no "Adam's Apple." This is one good way to

tell a "neck breather." You could obstruct this person's mouth and nose and it would not bring discomfort.

RESUSCITATING THE VICTIM

If a laryngect should stop breathing, the EMT would use the manual or mechanical artificial respiration that is used routinely, but it must be applied over the stoma.

As shown in Figure 27, the EMT must give mouth-to-stoma resuscitation with the victim positioned backside down, and the chin up and out of the way of the stoma. The EMT's mouth is placed over the stoma and mouth-to-stoma resuscitation, following the procedure learned for the mouth-to-mouth method, is given in this way. There is no problem of air going into the stomach because the EMT breathes directly into the windpipe. The tongue cannot obstruct the air flow, as the stoma is below it.

A laryngectomy victim may be resuscitated with a mechanical resuscitator. The baby mask should be fitted over the stoma in such a way as to create an airtight seal.

Figure 26. The absence of an "Adam's Apple" indicates that this person may be a neck breather

Figure 27. Mouth-to-stoma resuscitation is given

If the mask will not fit airtight, a moistened towel can be placed around the mask to seal off any openings. All face pieces of your resuscitation equipment should be inflated at all times.

When the resuscitator is put into service, it should be held over the stoma as it is over the face, with the index fingers and thumbs. A folded blanket can be used under the shoulder blades. The blanket or other material helps to keep the windpipe straight and the head back.

This type of victim is much easier to aspirate (suction) than the average resuscitation victim. If the resuscitator gives the blockage signal, mucus will be the usual cause.

The EMT must be sure to rotate the catheter while suctioning. The EMT in Figure 28 is doing so by rotating the aspirator tube between the thumb and index finger. The catheter should be pinched off as it is inserted into the stoma in order to prevent damage. It should not be inserted more than four inches.

There are clubs throughout the nation called the "Lost Chord Clubs." These clubs are sponsored by the American Cancer Society, and they are very interested in each EMT being keenly aware of the victim of a laryngectomy. When patients are released from the hospital with stomas, they are told to make themselves known to their local emergency medical services.

When released from the hospital, the laryngectomy victim may live a normal life. The victim who posed for these pictures has had a stoma for many years.

There is always the additional problem of visitors to your area who might be "neck breathers." The theme for the squadpersons is becoming "CHECK THE NECK FOR THE LARYNGECT."

Figure 28. An aspirator tube, inserted through the stoma, will remove mucus.

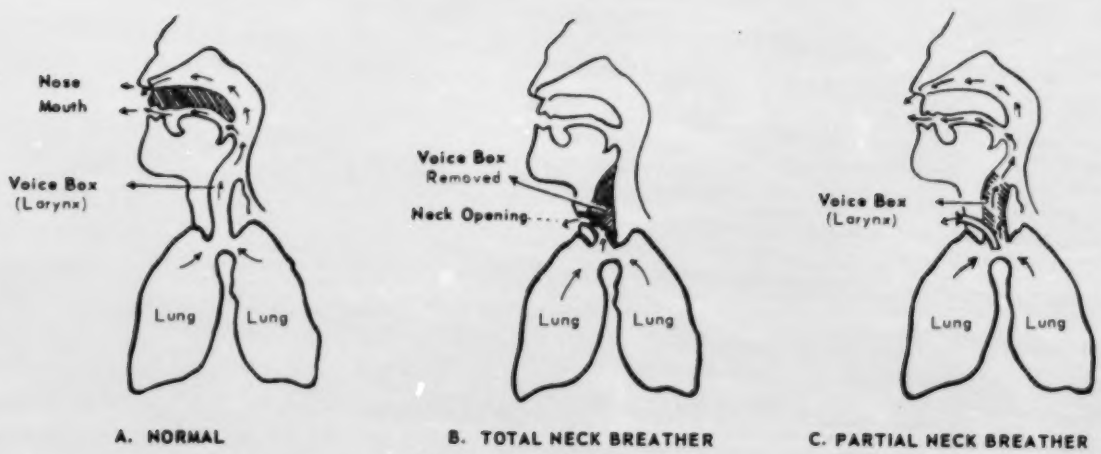


Figure 29. In summary, View A shows the breathing passages of the normal individual. View B shows the breathing passage of the total laryngect, and View C shows a partial neck breather.

Occasionally an individual may be found that is a partial neck breather. It must be remembered that in the resuscitation of this type of victim it may be necessary to seal off the nose and mouth if resuscitation is being administered through the stoma. A metal or plastic tube may or may not be present in the neck opening. If present do not remove it.

OXYGEN THERAPY

OBJECTIVES

Upon completion of the following chapter, you will be able to:
—describe the different methods of oxygen administration.
—describe the proper use and care of oxygen equipment.
—describe safety procedures required during oxygen administration.

Following instruction and/or practice, you will be able to:
—demonstrate different methods of oxygen administration.
—demonstrate proper care of oxygen equipment.
—apply safety procedures required for oxygen administration.

INTRODUCTION

Within the normal temperature range, oxygen exists as a gas. It is odorless, colorless, tasteless and, while not flammable by itself, it will readily support combustion of already burning objects. Oxygen may be of lifesaving value for victims experiencing heart trouble, shock, severe burns, blood loss, and/or respiratory distress.

As with all drugs, oxygen's benefits must be weighed against possible side effects and hazards associated with oxygen usage. Administration of oxygen may take many forms, and the EMT should be familiar with the equipment carried in the squad. Remember, oxygen is not a cure-all. Its use should be instituted only after carefully evaluating the victim's physical condition and need for oxygen.

INDICATIONS FOR USE

In the body, oxygen is carried by hemoglobin within the red blood cells circulating in the bloodstream. Indications for using oxygen, therefore, include any disease, trauma, or poisoning that interfere with the circulation of the blood; or diseases, trauma, or poisoning that interfere with the normal functions of the lungs or body tissues.

Respiratory and cardiac arrest or insufficiency, blood loss, shock, noxious gas inhalation, pesticide ingestion, smoke inhalation, and poison ingestion such as cyanide are all conditions which may require oxygen therapy. Physical findings include shortness of breath—real or imagined—irregular breathing, cyanosis, and the signs and symptoms of cardiac failure and shock.

Oxygen used in excess may, in some persons, result in respiratory arrest, damage to the lung tissues, or collapsed areas in the lungs. In newborns eye damage may result. These side effects associated with oxygen toxicity are usually seen only after prolonged usage at high concentrations, but the EMT must realize they exist. **Use oxygen when the need exists and not merely to be doing something to the victim.**

BASIC TANK SETUP PROCEDURE:

SETTING UP THE APPARATUS

All EMTs should be proficient in setting up and changing the portable oxygen tanks carried by their squad services. The large oxygen tank carried in the squad vehicle should only be changed by someone familiar with its operation.

1—Portable tank setup begins by removing the protective seal from the tank valve. Be sure to save the plastic washer provided. See Figure 1.

Courtesy Linde Co.

Figure 1. Remove protective seal

CRACKING THE VALVE

2—The valve should be turned counterclockwise (CCW) until a blast of gas is heard. Do not point the opening toward anyone while doing this. Then quickly close the valve (clockwise). This is called "cracking" the valve. This removes dust which may have lodged in the valve opening so it will not enter the regulator. See Figures 2 and 3.

REDUCING PRESSURE

3—A pressure-reducing regulator is then attached to the tank valve. The pins in the regulator must match the holes in the tank valve and the plastic washer must be in place before tightening the regulator to the valve. See Figure 4.

Courtesy Linde Co.

Figure 2. Open valve slightly

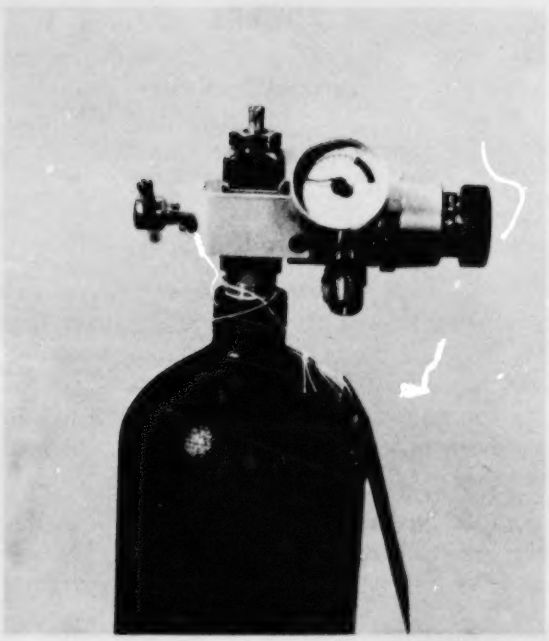
Courtesy Linde Co.

Figure 3. Close valve quickly

REMOVING THE REGULATOR

4—If removing the regulator from an "empty" tank, first turn the tank valve off (clockwise). Then bleed the line by pushing in the demand

valve trigger to release any pressure in the regulator and the attached hoses. Remove the regulator and mark the tank "empty" or "MT." See Figure 5.



Courtesy Linde Co.

Figure 4. A pressure-reducing regulator must be attached to the cylinder before oxygen can be administered to the patient

TESTING FOR LEAKS

5—Once the regulator is in place turn the tank valve on to pressurize the regulator. If there are any leaks, escaping gas will be heard. Also check the pressure gauge to make sure the tank is full when attached. If the tank checks out, turn the valve off and bleed the lines before storing the tank for future use. See Figure 6.

LARGER TANKS

Setup for larger tanks is similar, but the regulator is threaded onto the tank valve instead of the pin index system used on the "D" and "E" cylinders. See Figure 7.

Figure 5. Remove the regulator and mark the tank "MT"

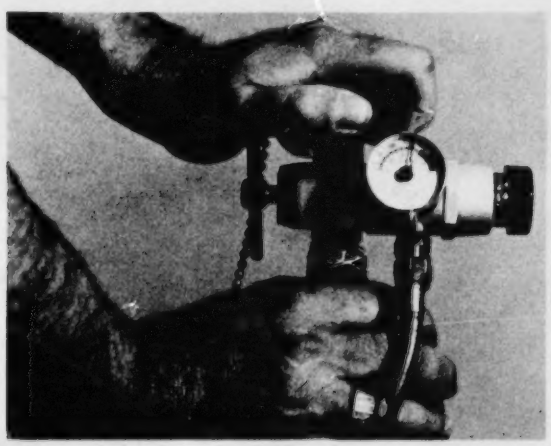


Figure 6. Once the regulator is in place turn valve on to pressurize the regulator

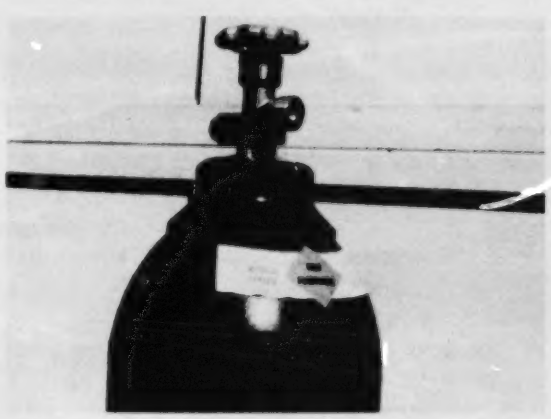


Figure 7. Large bottle with threaded valve

FLOWMETERS

In order to deliver oxygen at the desired level, a flowmeter is used. Portable resuscitators usually have the flowmeter attached directly to the pressure-reducing regulator. See Figure 8. In the squad vehicle, the flowmeter plugs into a wall receptacle. Each "brand" of flowmeter fitting will fit only into a like-brand receptacle. Both flowmeter types may be adjusted from 0 to 15 LPM.

Once the flow of oxygen is adjusted for the victim, the oxygen tubing is attached to the flowmeter via a nipple adapter. Most flowmeters have a metal ball or pin that floats in a plastic column or a needle to indicate the flow rate.

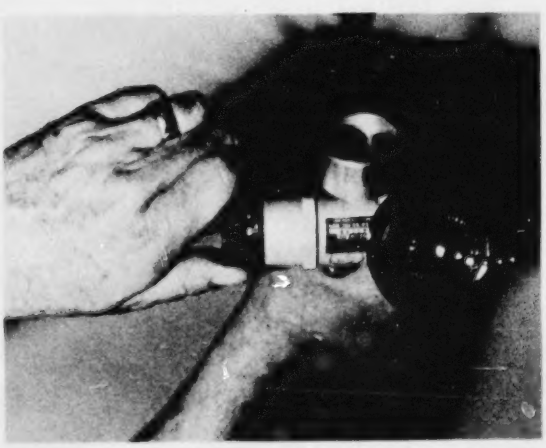


Figure 8. Portable tank with flowmeter

ADMINISTRATION

Once the need for oxygen (O_2) has been determined, the EMT must decide which device to use and how much oxygen to administer. If the victim is conscious, ask if the victim has a lung ailment such as emphysema or black lung disease. A victim suffering from lung disease should be administered no more than three LPM of oxygen. The medical history of an unconscious victim is usually not known; therefore it is advisable to administer oxygen starting at two to three lpm. One must consider the concentration desired and what device the victim will tolerate.

METHODS

Oxygen is delivered to adults via (1) nasal cannula, (2) simple face mask, (3) complex face mask, and (4) resuscitation device.

The *nasal cannula* is the least effective way to deliver high oxygen concentrations, but is usually the best tolerated by the victim. Many of the victims seen by EMTs, however, do not need high oxygen concentrations so use of the cannula is well suited. The nasal prongs (Figure 9) of the cannula are placed in the victim's nose. The tubing is then placed over the ears and under the chin and tightened, or a strap is placed around the head.

The flow rate is then adjusted from ½ to 8 liters per minute (lpm). This will deliver from 22% to 50% oxygen to the victim. Open-mouth breathing does not significantly affect the oxygen concentration delivered by the nasal cannula. Remember the victim's nose must be clear and open.

Simple face masks (Figure 10) will deliver oxygen concentrations of 35% to 55%, but are not tolerated well by a victim who fears suf-

Figure 9.
Nasal prongs

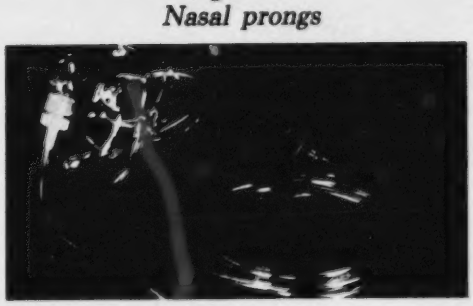


Figure 10.
Simple face mask

focation by the mask. It is important to explain to the victim why oxygen is needed before placing the mask over the mouth and nose.

All unconscious victims wearing masks must be watched closely. If they vomit, remove the mask and clear the airway or aspiration into the lungs may occur.

Complex face masks may be used to deliver oxygen concentration of 90% to 100%. The mask used to achieve high oxygen concentrations is a non-rebreather mask. This mask has a reservoir bag attached to the mask. Oxygen is fed into the bag. As the victim inhales, a one-way valve opens and lets oxygen from the bag into the mask. When the victim exhales, the valve shuts so the victim does not breathe back into the bag. This permits high oxygen delivery with no carbon dioxide buildup.

For proper operation the one-way valve must be present and enough oxygen flowing into the bag-reservoir to keep it inflated. The flow rate will depend upon the victim's rate and depth of breathing. Usually eight to 10 liters per minute will do.

The rebreather mask is simply a non-rebreather mask with the one-way valve removed. Oxygen is delivered at flow rates of six to 10 lpm, but with the valve missing the victim's exhaled gases are also added to the bag. When the victim inhales the oxygen and part of the last exhaled breath is breathed in, a gradual buildup of carbon dioxide in the bloodstream results.

The best test of whether a conscious child needs oxygen is whether or not the child accepts it. As long as the child is more comfortable with it than without it, oxygen administration is appropriate. The child should be introduced to the mask slowly and gently, as some children are initially fearful of masks. Oxygen should be given to all unconscious children and to all children in shock who do not resist it. Humidification is not needed for administration less than 15 minutes.

Flow rates:	
Infants	2-4 liters/minute
Older children	4-10 liters/minute

ESOPHAGEAL OBTURATOR AIRWAY/ ESOPHAGEAL GASTRIC TUBE AIRWAY

The esophageal obturator airway (EOA) and esophageal gastric tube airway (EGTA) are recent innovations in the management of respiratory arrest victims. See Figures 11 and 12.

The advantages of the EOA/EGTA are that no direct visualization of the trachea is required for insertion and it can be introduced more easily and quickly than an endotracheal tube. In a large number of respiratory arrest cases, the airway has been shown to be used successfully without injury to the esophagus when used by allied health personnel using training manikins and unconscious victims. However, the potential for damage to the esophagus is ever present unless use of the airway is restricted to adequately trained individuals.

Before inserting the EOA/EGTA the victim must meet certain criteria. The three main criteria are: a) victim must be unconscious, b) victim must not be breathing, c) victim must be an adult (at least 5 feet tall and 16 years old). Additional considerations preventing usage are: a) history of signs of caustic poison ingestion, b) known esophageal disease.

PREPARATION OF THE EOA FOR INSERTION

Before insertion, the EOA must be checked and prepared for use. Following is a step-by-step procedure for this purpose.

1. *Check* the tube cuff. A check at this time with 15cc to 20cc of air in the cuff will insure the cuff's capability to hold air. This check is

important because of storage problems. The cuff may have been damaged while in storage.

2. *Connect* the esophageal tube to the face mask. Insert the male connector into the female receiver until you hear the lock-ring snap in place. The mask freewheels around the connector and will probably have to be rotated to its proper position after insertion.

3. *Check* the face mask cuff for proper inflation. Overinflation or underinflation will not allow a proper seal to be made on the patient's face.

4. *Lube* the esophageal tube. Lubricate the tip of the tube *below* the cuff with a *water soluble jelly.*

5. *Set* the syringe at the 35cc mark. It may not be necessary to use 35cc of air to fill the tube cuff, but it will be there if you need it. The syringe is needed to fill and deflate the tube cuff; keep it where it is accessible to the EMT inserting or removing the airway.

The EOA is now ready for insertion. A step-by-step procedure of this follows.

1. Non-responsiveness should be determined by shaking the victim and shouting, "Are you all right?"

2. Open the airway by head tilt-chin lift or other method. Check for breathlessness for 10 seconds.

3. If not breathing give the victim four, quick breaths. Determine adequate chest rise or breath sounds present. DO NOT INSERT WITHOUT FIRST CHECKING FOR AN OPEN AIRWAY.

4. Return head to neutral position, grasp jaw and pull forward with left hand. Insert EOA/EGTA tube with mask attached down rear of pharynx following the natural curvature of the throat until the mask tightly **"sits"** on face.

5. Because there is always the possibility the tube may be lodged in the trachea, the next step is to ventilate with the cuff deflated, observing for chest expansion or breath sounds.

6. If the chest rises, the cuff may be inflated with 35cc of air. If valve is in **two** pieces make sure it does not come apart when withdrawing the syringe. If the chest does not rise, remove tube immediately since the tube may be in the trachea.

7. With the face mask properly fitted over the face and the cuff inflated, air may be introduced into the proper ventilating part on the mask either by blowing into it or with a bag-valve device connected to oxygen on a mechanical resuscitator.

Removal of the airway should be done immediately if there is no chest rise, or after an endoctracheal is in place, or when the victim recovers. Suction devices should be immediately available since vomiting may occur.

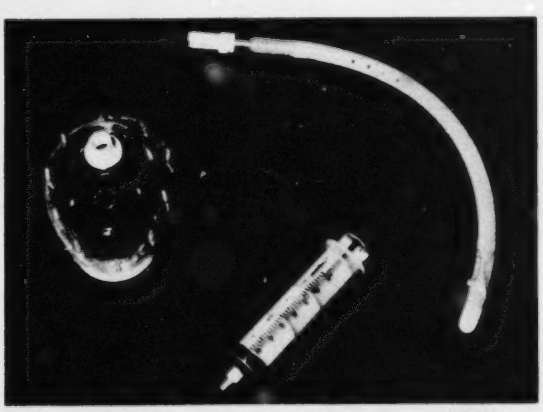


Figure 11. The esophageal obturator airway

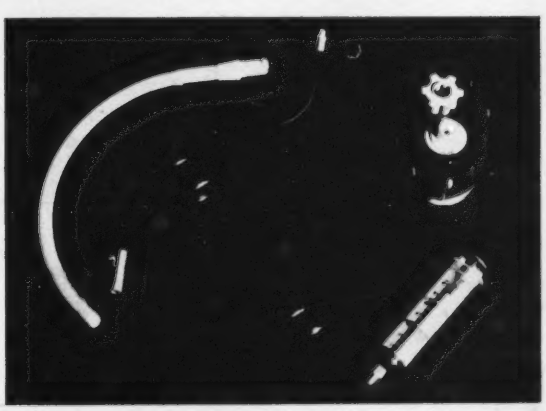


Figure 12. The esophageal gastric tube airway

The esophageal obturator airway has a mask with **one** ventilation hole in it. The ventilating tube is snapped into the mask before insertion. Once the cuff is inflated with 35cc of air, thereby blocking (obturating) the esophagus, air or oxygen blown into the ventilation part will exit the 16 small holes in the tube into the pharynx and then travel to the lungs.

The esophageal gastric tube airway has a mask with **two** holes in it. The lower hole has spokes around it to prevent ventilation there. The tube snaps into this position. The second upper hole is for ventilation and is marked "ventilate here." The EGTA is inserted like the EOA but, once in place, a nasogastric tube may be passed through the EGTA tube to allow decompression of the stomach. Ventilation occurs through the mask as with a bag-valve mask.

MAINTENANCE OF EQUIPMENT

Masks—Soak all parts in a detergent-disinfectant solution for 20 minutes. Rinse thoroughly and dry.

Catheters—Wash rubber catheters thoroughly with care given to the holes on the tip. These should not be obstructed. Soak catheters for 20 minutes in detergent-disinfectant solution. Rinse and dry. Wrap them in clean materials to be ready for later use.

The preferred catheter for emergency services is the plastic disposable type. Used only once, the cleaning problem is eliminated. It is also inexpensive.

Hospital emergency room personnel often cooperate by exchanging a clean catheter for a soiled one. They have the proper facilities to sterilize rubber goods.

SAFE PRACTICES

All tanks should be held securely in the apparatus. The constant motion of the emergency vehicle during calls will cause a dangerous situation if oxygen tanks are not held in place by straps, tank wells, blocks, or some other type of fixture.

DO'S AND DON'TS FOR SAFETY WITH OXYGEN CYLINDERS

"Crack" cylinder valve prior to attaching regulator by opening slightly and then closing again. This procedure blows dust and debris out of the cylinder valve opening.

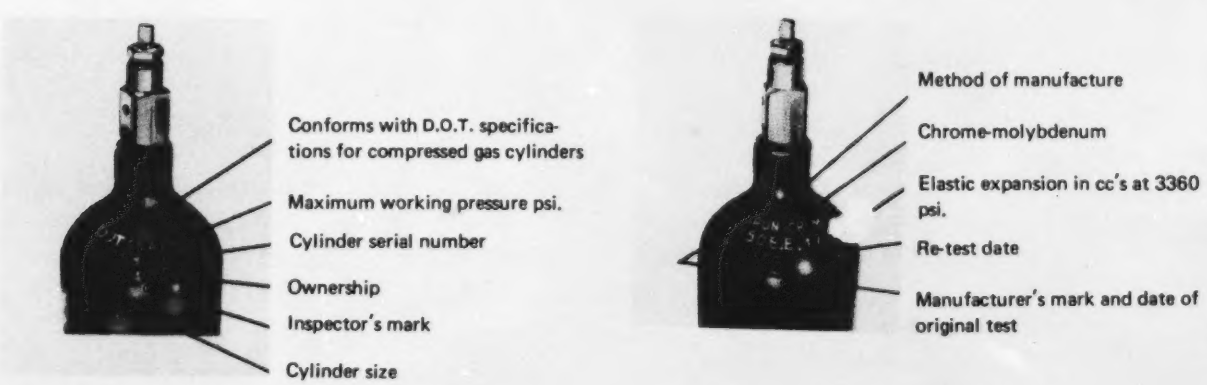


Figure 13. Information and specifications that are stamped on all oxygen and other compressed gas cylinders.

Open cylinder valve slowly to give heat of compression a chance to dissipate.

Keep regulator inlet filter clean and intact to prevent lint from collecting on the valve seat. Replace as required.

Don't use oil or grease on oxygen equipment; combustion may occur.

Don't smoke or use open flame near oxygen. (Oxygen vigorously supports combustion.)

Have worn or frayed valve seat inserts replaced. They are much more subject to ignition when worn or frayed.

Don't use regulators and equipment that have been used with other gases. Flammable residues may remain in these regulators.

Discourage repairs by unqualified personnel. If your equipment is worth repairing, it is worth repairing properly and safely.

Keep soap **away** from high pressure connections; it is flammable.

Don't use cylinders for hat trees or clothes racks. If there is a leaky connection, hanging clothes may ignite easily.

All oxygen tanks **MUST** have a pressure test (hydrostatic test) at least once every five years. The new tanks being manufactured today require testing every 10 years. All tested tanks have the date stamped on them. See Figure 13. **Oxygen distributors will test tanks at a minimal cost.** A new test date will be stamped on the bottle by the distributor.

Many services fill smaller tanks from larger tanks. These smaller tanks **MUST** have the hydrostatic tests within a five-year period.

MASS EMERGENCY OXYGEN THERAPY

In a special emergency, oxygen in substantial quantities may be required to care for large numbers of victims. It is not expected that local hospitals or emergency medical services will have on hand enough oxygen therapy equipment or oxygen to take care of such an emergency. Therefore, supplemental equipment and oxygen will be required.

COMMERCIAL SOURCES

Oxygen is available from distributors of oxygen, oxygen-producing plants, industrial plants, welding shops, automobile repair shops, scrap yards, and oxygen therapy rental services. See the yellow pages of your telephone directory under "Oxygen".

NOTE: Cylinders of oxygen obtained from the above sources may not be as clean outwardly as cylinders prepared especially for medical use, but their contents will be U.S.P. oxygen unless stated differently on the cylinder. Be sure the word "oxygen" is on the cylinder. Cylinders of similar size, shape, and color might contain other gases that can be harmful.

Pressure-reducing regulators must be used on all high-pressure cylinders of oxygen. Hospital-type regulators and other oxygen therapy equipment, such as tents, masks and catheters, can be obtained from the manufacturers of such equipment and oxygen therapy rental services. Regulators of the industrial type can be obtained from most places where oxygen is available. See the yellow pages of your telephone directory under "Oxygen".

NOTE: Industrial-type regulators differ from hospital-type regulators in that they do not have a restricted outlet and are calibrated in pounds per square inch instead of liters per minute. However, such regulators can be used in an emergency by opening the control valve very slightly, or by attaching a liter-flow adapter to the regular outlet. Liter-flow adapters can be obtained from suppliers of hospital regulators.

IMPROVISED EQUIPMENT

1. Oxygen can be administered by inserting a piece of tubing or welding hose through the bottom of an ordinary paper bag and holding the top of the bag over the victim's face. Use a generous flow of oxygen.

2. Make a cone of cardboard, old X-ray film, stiff paper, or similar material. Insert the oxygen hose through the bottom of the cone and hold the top over the victim's face.

3. In a cardboard carton about 20 inches square, cut a hole about nine inches in diameter in the center of the bottom. Slide the victim's head through the hole. Insert the oxygen hose through the side of the carton opposite the victim's head. Leave the top of the carton open or cut the top off entirely.

EMERGENCY HELP

Persons familiar with oxygen and equipment can be located at any of the places where oxygen is available. These persons are not necessarily familiar with oxygen therapy techniques but they should understand the mechanics of attaching a regulator to a cylinder.

OXYGEN TANK CAPACITIES

The three common oxygen tanks (see Figure 14) used by Emergency Medical Services today are:

"D" — size used in most portable resuscitators

"E" — found in some portable inhalators

"M" — the most common size built into the emergency vehicle.

An oxygen tank, regardless of size, is under a pressure of approximately 2,000 pounds per square inch when full. However, the size determines the amount of oxygen in the tank. The capacities are:

"D" tank—360 liters

"E" tank—625 liters

D E M

Figure 14.

"M" tank—3,200 liters

With these figures an EMT can determine how long a certain size tank will last if it is flowing a certain numbers of liters. For example:

A "D" tank with 360 liters of oxygen and flowing 10 liters per minute will last approximately 36 minutes.

When using a resuscitator:

A "D" tank will last approximately 10 to 20 minutes.

An "E" tank will last approximately 20 to 40 minutes.

An "M" tank will last approximately three to four hours.

The above usage will depend upon the operator. How much oxygen leakage is there and how much oxygen is getting into the victim's lungs?

Available EMS Publications

For ordering and pricing information contact:
Vocational Instructional Materials Laboratory
The Ohio State University
154 W. Twelfth Avenue
Columbus, Ohio 43210
Phone (614) 422-5001

Emergency Victim Care—Student Manual (EVCM)
Emergency Victim Care—Instructor Manual (EVCIM)
Emergency Victim Care—Workbook (EVWB)
EMS Binder—2½" Three-ring binder (EMTB)
Advanced EMT Instructor Manual (EVAIM)
EMS Slide/Tape Series
—Bleeding Control — 42 slides (EMST-1)
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—Anatomy and Physiology (EMST-9)
Victim Rescue Manual—Student Manual
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River Rescue Manual—Student Manual
River Rescue Manual—Instructor Manual
Farm Accident Rescue Manual